Measurement of $J/\Psi \rightarrow e^+e^-$ and $\chi_c \rightarrow J/\Psi + \gamma$ in dAu collisions at PHENIX/RHIC

Alexandre Lebedev, Iowa State University
for the PHENIX Collaboration

1. Motivation
2. J/Ψ measurement
3. χ_c measurement

Motivation

If quark- gluon plasma (QGP) is formed in relativistic heavy ion collisions, color screening will lead to suppression of charmonium production (*T. Matsui, H. Satz, Phys. Lett. B178(1986)416*). A promising signal of QGP formation.

More recent studies predict increased J/Ψ production at RHIC due to recombination (*R.L. Thews et al, Phys. Rev. C63(2001)054905*).

It is important to measure simulataneously several charmonium states, e.g. J/Ψ and χ_c to find out which models of charmonium production work best.

dAu collisions, along with pp, provide a baseline for understanding J/Ψ and χ_c production in AuAu.

The PHENIX Experiment

The PHENIX experiment at RHIC has the unique ability to measure both J/Ψ and χ_C in relativistic heavy ion collisions.

Charged particle tracking and the momentum measurement by the Drift Chamber.
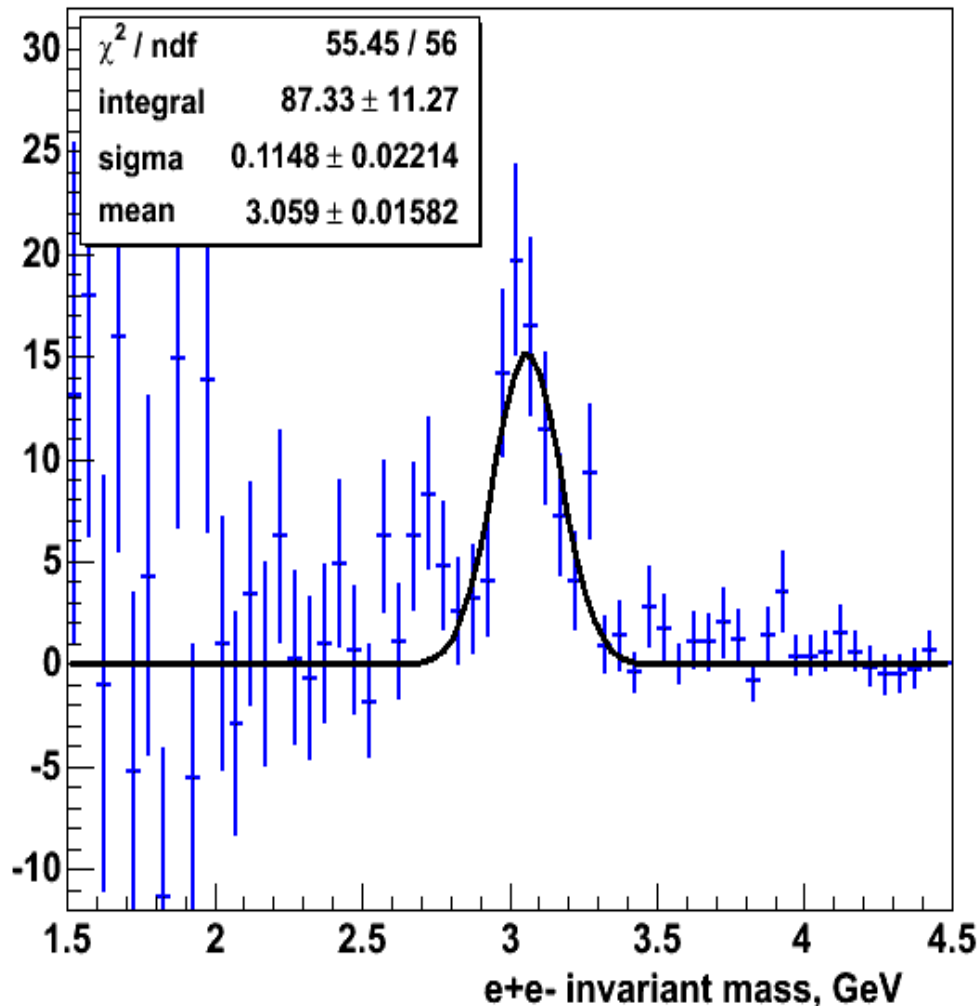
Electron identification in Ring Imaging Cherenkov Detector and Electromagnetic Calorimeter (EMCal).

Photon Identification in EMCal

Muon tracking and identification in Muon Arms.
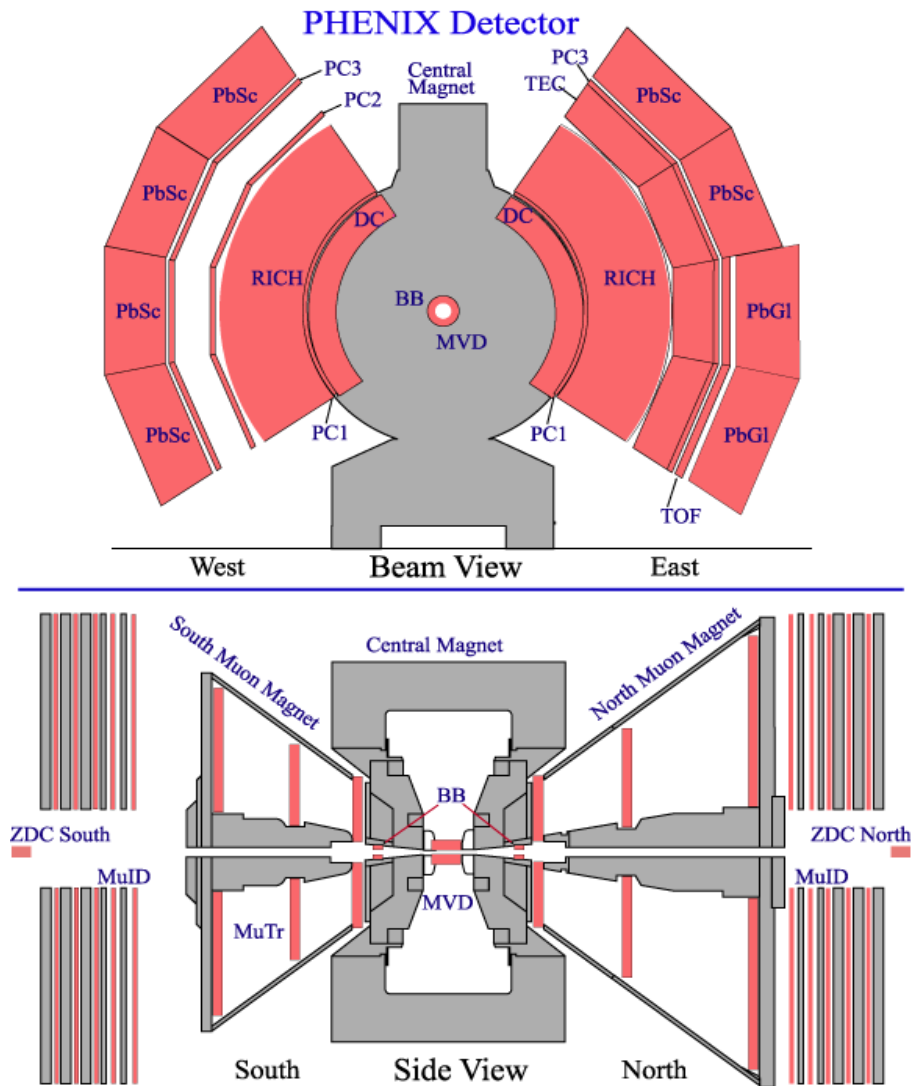
J/Ψ measurement in the PHENIX Central Arms


The plot shows e+e- invariant mass distribution for 20%- 25% of all run3 dAu data.

Combinatorial background is subtracted The background was caculated using mixed events method (same sign background does not work in Phenix). Background is normalized using the number of same sign pairs.

In all of run3 dAu we can expect to have 400- 500 J/Ψ. With looser vertex and electron ID cuts we can get as many as ~700 J/Ψ.
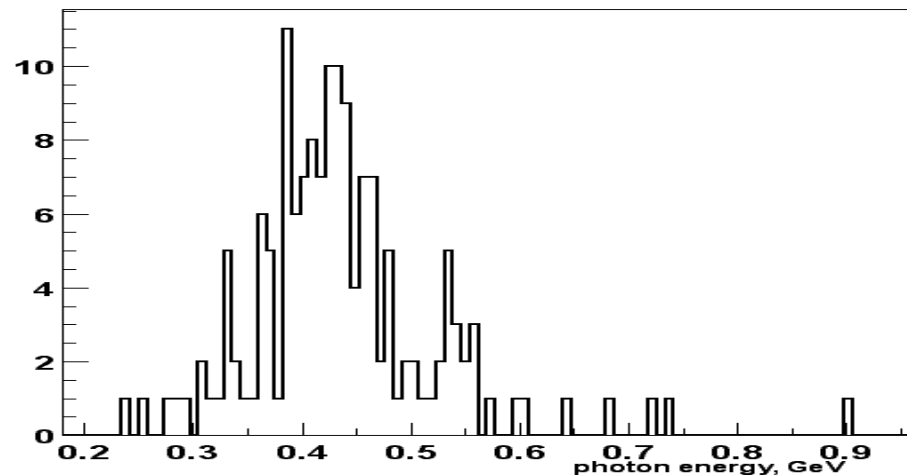
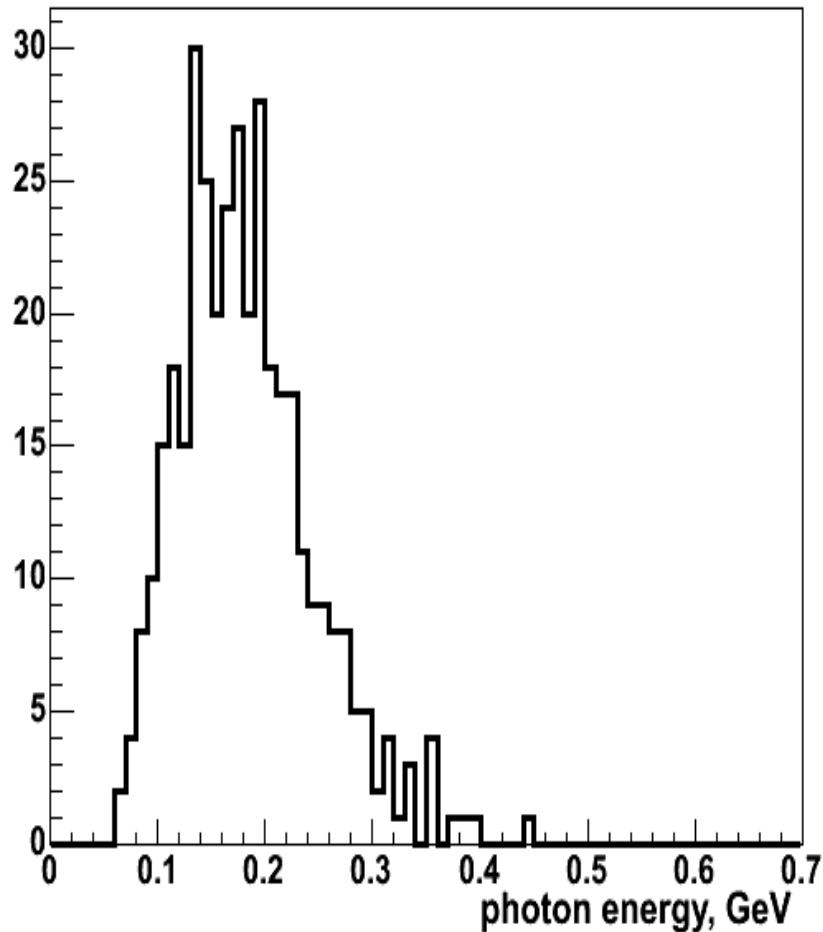# Acceptance for $\chi_c \to \gamma + J/\Psi \to e^+ e^-$
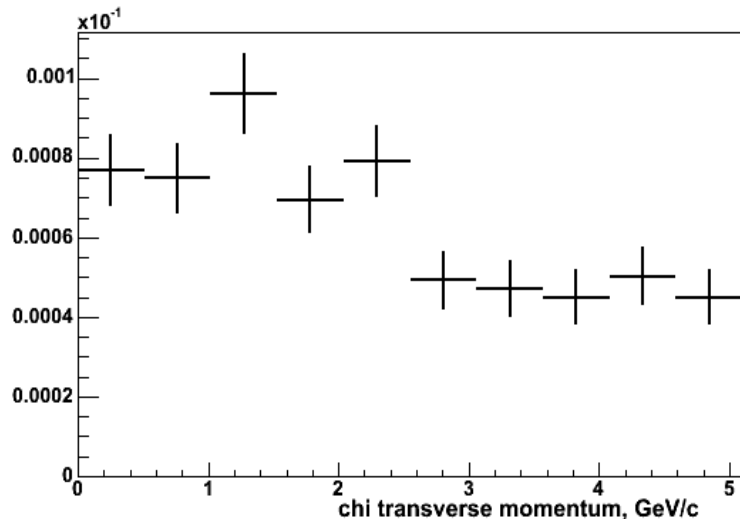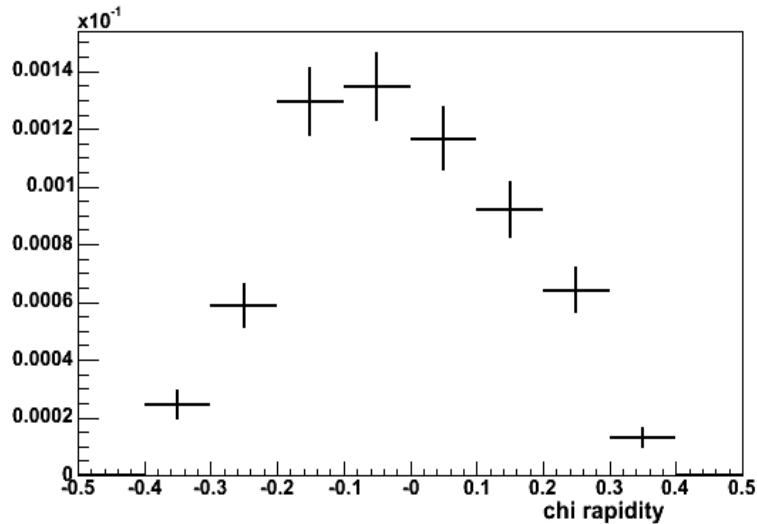
To calculate χ_c acceptance, a simulation using single χ_c was done.

If J/Ψ is detected in the Phenix Central Arms, the probability to detect the photon is 11%

Assuming that 40% of J/Ψ come from χ_c, we can expect few tens of reconstructed χ_c in all run3 dAu data.

Acceptance for $\chi_c \rightarrow \gamma + J/\Psi \rightarrow \mu^+\mu^-$

In case of J/Psi decaying to $\mu+\mu-$, the probablility to detect the photon in Central Arms, while muons are detected in Muon Arms is 2.5%.

Expected number of reconstruced J/Ψ in Muon Arms is ~1000 per arm, which makes the expected number of reconstructed χ_c in this channel comparable to e+e- channel.

However, the photon energy is very low, which makes χ_c measurement using Muon Arms practically impossible.

# Background estimate for $\chi_c \rightarrow J/\Psi + \gamma$
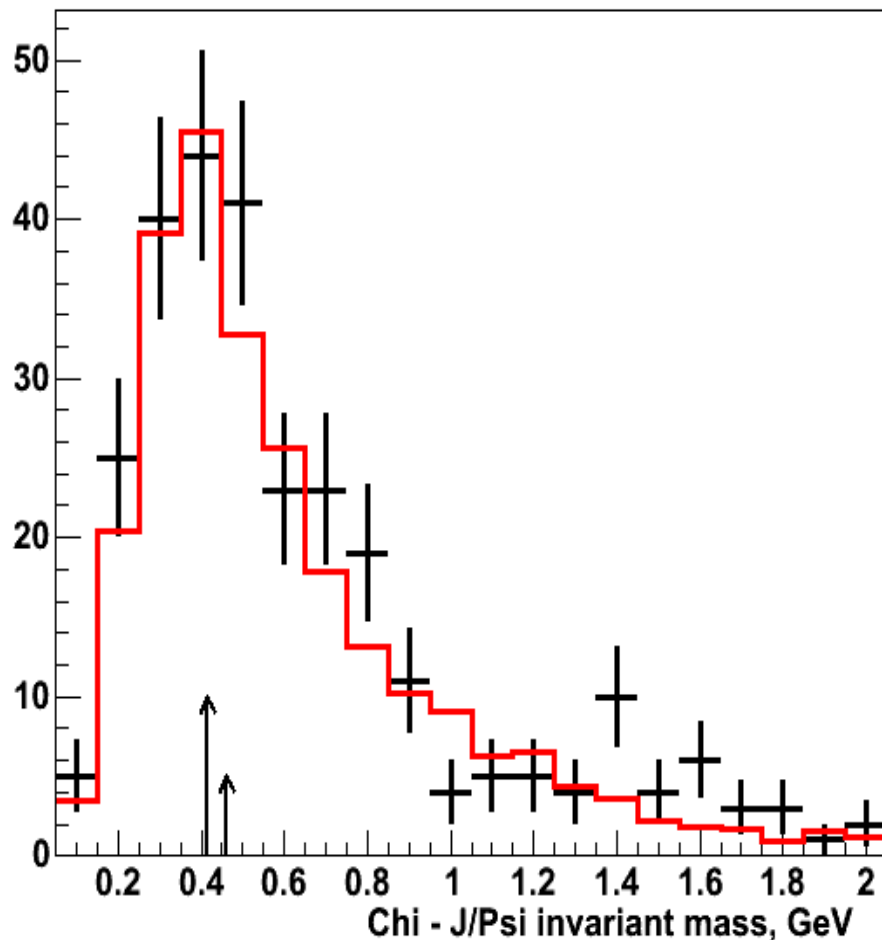
The plot shows χ_c - J/Ψ invariant mass distribution for 20%- 25% of all run3 dAu data. Several χ_c are expected in this plot.

Red histogram shows combinatorial background calculated using mixed events method.

The width of χ_c peak is expected to be ~55 MeV (from EMCal resolution and full scale simulations).
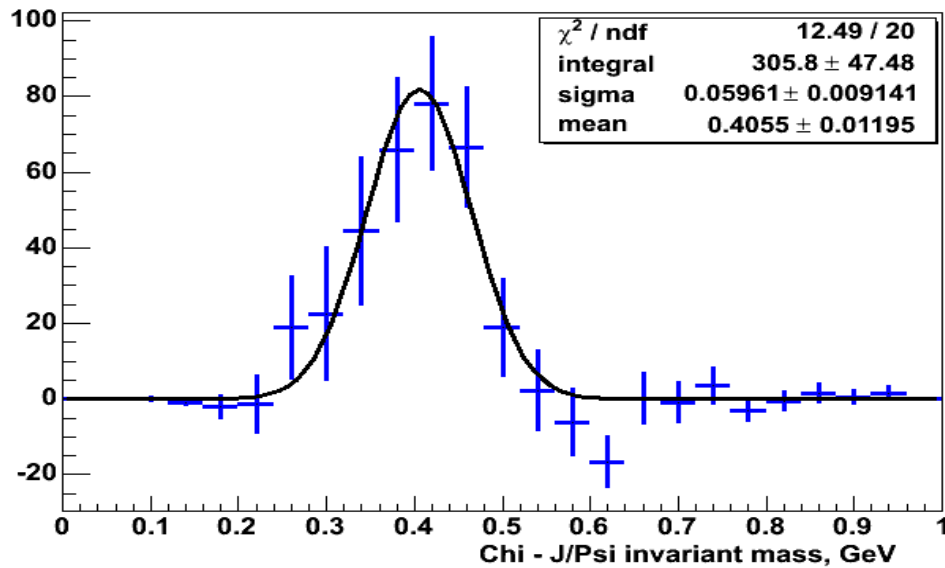
Combinatorial background will be 100- 200 counts per 100 MeV bin.

Full scale simulation
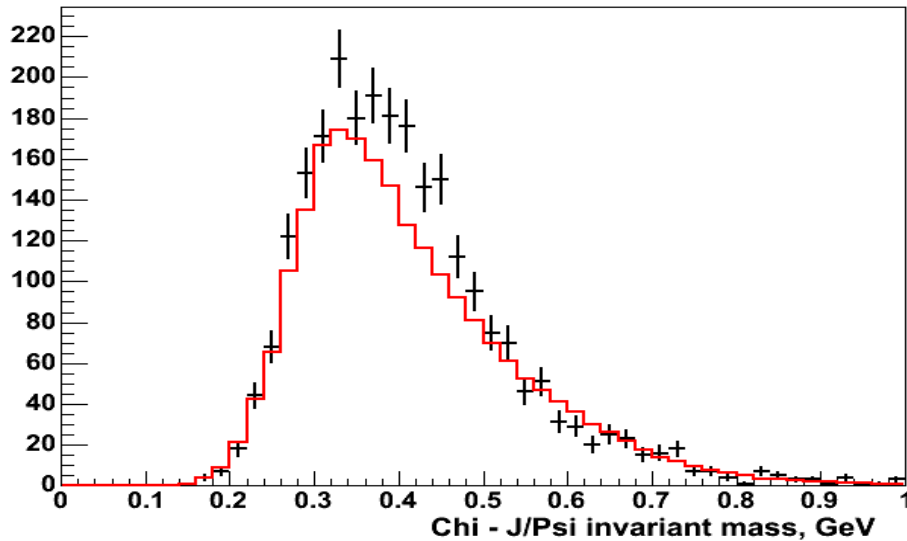
For a more realistic study, single J/Ψ and χ_c were merged with simulated dAu events, and complete data analysis was performed.
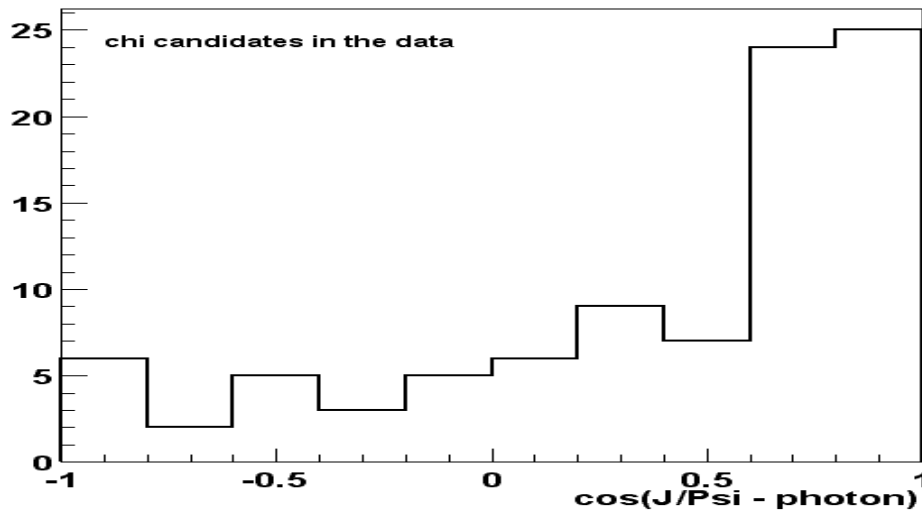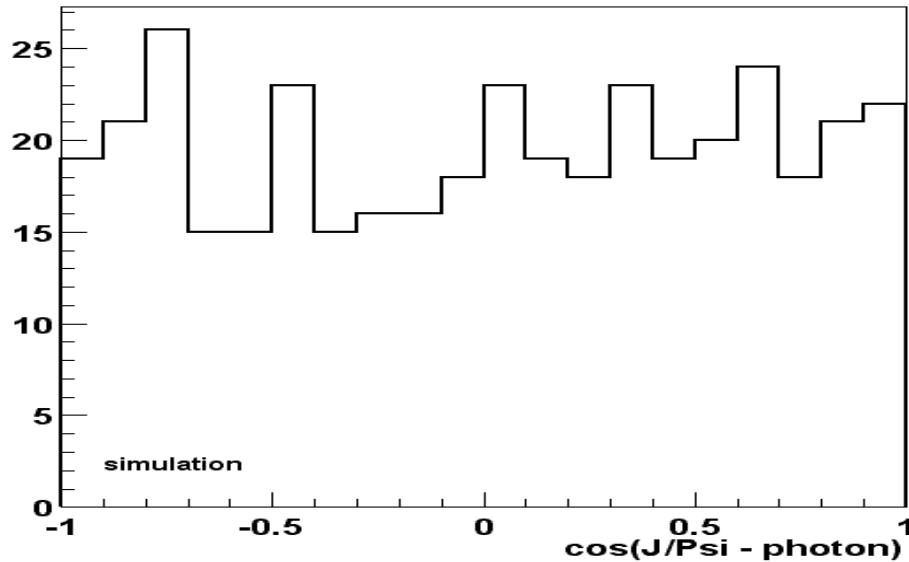
40% of events with merged χ_c were added to 60% of events with merged J/Ψ

Red histogram in the top plot shows combinatorial background calculated using mixed events method. Background was normalized at the tail of the distribution (mass>0.55 GeV).

This plot corresponds to 5-6 times larger statistics than we expect in run3 dAu.

Ways to reduce background

1. Changing photon energy cut.. Lower cut will move the maximum of the background to lower masses.

2. Use angle between the photon and the J/Ψ. The background is peaked at small angles.

3. Use correlation between the photon and electron momenta. Momentum of the electron in the same arm with the photon is correlated with the photon momentum.

4. Remove photon pairs which have pi- zero mass.

Conclusions

The ongoing $J/\Psi \rightarrow e^+e^-$ and $\chi_c \rightarrow J/\Psi + \gamma$ analysis in dAu collisions was presented.

~500 J/Ψ are expected to be reconstructed in run3 dAu.

Expected number of reconstructed Chi is few tens, while combinatorial background is expected to be 100- 200 counts per 100 MeV

In Central Arms Chi measurement is difficult but feasible, while in Muon Arms it is impossible due to low photon energy.